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The Status, Distribution and Abundance of *Dasyurus maculatus* (Tiger Quoll) in Australia, with particular reference to Victoria

IAN MANSERGH

Arthur Rylah Institute for Environmental Research, P.O. Box 137, Heidelberg, Victoria 3084.

ABSTRACT

Dasyurus maculatus (Tiger Quoll) is considered to be an uncommon to rare animal on the Australian mainland. However, it is apparently more common in Tasmania and some areas of northern New South Wales. It is very rare or extinct in South Australia. The species inhabits a variety of forest types along the Great Dividing Range and is most commonly found in areas where the mean annual rainfall exceeds 600 mm. The range of the species on the mainland has been reduced. For example, since European settlement of Victoria the range of this species has been reduced by about 50% and is now disjunct. *D. maculatus* is now a rare animal in Victoria and the most important areas for its conservation are East Gippsland, the Otway Range and around the "Stones" in the southwest of the state. Factors presumed to have been involved in its decline include habitat destruction and the widespread use of trapping and poisoning. More research into the ecology of the species is required.

INTRODUCTION

Dasyurus maculatus (Tiger Quoll or sometimes known as Tiger Cat) is the largest marsupial carnivore extant on the mainland of Australia and its previous range included Tasmania, South Australia, Victoria, New South Wales and Queensland (Fig. 1). Information concerning this species is scant. For areas where documentary evidence (both scientific and general literature) exists regarding its occurrence it appears that *D. maculatus* was not a common animal during the first century of European settlement in Victoria and other states. This is in contrast to *D. viverrinus* (Eastern Quoll or sometimes known as Eastern Native Cat) which was relatively common in many areas (Fleay, 1932; Wakefield, 1954). All accounts which suggest that *D. maculatus* was common in Victoria are considered by the author to be questionable because the records are invariably associated with emotive circumstances, for example the killing of poultry, or remain ambiguous because *D. maculatus* and *D. viverrinus* are both discussed as "native cats" (e.g. Morrison, 1948a and b).

The rarity and declining status of *D. maculatus* in Victoria was noted by Fleay (1932). It has been suggested that the species suffered from a disease, similar to that believed to have caused the dramatic decline of *D. viverrinus* early this century. However no direct documentation is available on this (Jones, 1923; Lewis, 1934; Caughley, 1980). Habitat destruction, persecution and the widespread trapping and poisoning in and around forested areas may have been more important factors in the decline of *D. maculatus* in Victoria than the presumed disease.

Begg (1981) noted the dearth of knowledge concerning *Dasyurus* spp. However, his research on *D. hallucatus* (Northern Quoll), and Godsell's (1982) study on *D. viverrinus* have added greatly to our knowledge of the genus. No recent substantial studies of *D. maculatus* have been undertaken in Victoria. Discussion of the distribution and abundance of the species frequently relies on comments such as those given by Fleay (1948). In an attempt to rectify this situation I have reviewed in detail the currently available data on the status, distribution and abundance of *D. maculatus* in Victoria and have compiled the most recent parallel data for other states (e.g. Caughley, 1980).

METHODS

Data were compiled from the literature, records held by the Fisheries and Wildlife Division of Victoria (FWD), all major museums in Australia, the British Museum (National History), the Victorian Department of Crown Lands and Survey (DCL&S), the Victoria Archaeological Survey and the Royal Zoological Gardens, Melbourne. Details provided by local residents of Gippsland, the Otway Range area and southwestern Victoria were also used. Past and present dog trappers (employed by Department of Crown Lands and Survey for trapping wild dogs) were interviewed. Localities, dates of capture and other information were compiled from all reliable records.

Records of the Fisheries and Wildlife Division concerning *D. maculatus* were derived from one of three sources: files containing memoranda, correspondence and newspaper articles. Annotated data sheets of specimens or sightings and trapping records of the Wildlife Survey Unit were also used. The latter records, collected since 1973, were derived from several extensive fauna surveys conducted on public land south of the Great Dividing Range (Emison *et al.*, 1975, 1978; Norris *et al.*, 1979, 1983, pers. comm.; Menkhorst and Gilmore, 1979; Menkhorst and Beardsell, 1982). Over 75,000 trapnights were completed during these surveys, the majority of which were undertaken using wire cage traps (30 cm x 20 cm x 16 cm) baited with a mixture of peanut butter, rolled oats and honey. Such traps and bait are known to capture at least juvenile *D. maculatus* (Emison *et al.*, 1978), and therefore would be able to capture juveniles from about October through to the end of March. One record was derived from a Wildlife Survey Unit *D. maculatus* trapping program (280 trapnights) in which wire cage traps (25 cm x 25 cm x 70 cm) were

baited with a variety of baits including fish, *Macropus giganteus* (Eastern Grey Kangaroo), sheep livers, roadkilled *Platycercus elegans* (Crimson Rosella) and dead rabbit which had its fur singed. A single animal was caught on a piece of singed rabbit.

The distribution of *D. maculatus* sightings and captures was plotted on a grid map of Victoria (5 minutes latitude by 5 minutes longitude). In evaluating distribution, records were temporaraily grouped as pre-1960, 1960-69, and 1970-79. The recent records took precedence where records from different periods were coincident. Records were also sorted by date, into decade of occurrence. Records of the species in Tasmania, South Australia, New South Wales and Queensland were compiled from the most recent literature (e.g. Kitchener *et al.*, 1981) and consultation with

Fig. 1. The Australian distribution of *D. maculatus* showing recent (post-1974) and past (pre-1975) records.

the respective museums. Other records collected by the author have also been included. To conform to other studies (Caughley, 1980) these data were temporarily grouped pre-1975 and post-1974 (Fig. 1).

RESULTS AND DISCUSSION

Results are summarised in Table 1 and Figures 1, 2 and 3. They show past and present distribution of *D. maculatus* in Australia and Victoria, areas in Victoria where *D. maculatus* is now most frequently recorded and the temporal distribution of twentieth century records collected in Victoria. A bibliography of the 185 references examined is lodged in Fisheries and Wildlife Division, File 93-1-42. A resumé of the status, distribution and abundance is provided for all states where the species is known to have occurred.

The Tiger Quoll is limited to eastern Australia and the previous range approximated the areas that receive a mean annual rainfall in excess of 600 mm, (see Fig. 2 for Victoria) the notable exception is the northern Queensland population where

Fig. 2. The Victorian distribution of *D. maculatus* showing 600 mm isohyet.

the species appears to have been limited to areas that received a mean annual rainfall in excess of 1000 mm. Within this range the species inhabits Closed forest, Tall open-forest, Open-forest and is occasionally recorded in Woodland (Specht *et al.*, 1974).

Tasmania

The distribution of *D. maculatus* is patchy in Tasmania with most records occurring in the Closed forest and Tall open-forests (Specht *et al.*, 1974) of the western highlands and the northeastern and northwestern regions (Green, 1973). Sub-fossil remains of *D. maculatus* have been recorded on King, Flinders and Cape Barren Islands in Bass Strait. Spencer and Kershaw (1910) erected *D. bowlingi* as a Tiger Quoll endemic to King Island and possibly Deal Island, however, Marshall and Hope (1973) concluded that this species was conspecific with *D. maculatus*. The species is now extinct on King Island (most recent sighting 1923) and 'very rare' on the other islands (Hope, 1972). As elsewhere, *D. maculatus* is not as common as *D. viverrinus,* however, there is anecdotal evidence to suggest that both species are recovering from a population decline earlier this century (Andrews, 1981; Godsell, 1982; Green, 1973; Munday, 1966). *D. maculatus* is regarded as common to uncommon in Tasmania (Green, Queen Victoria Museum and Art Gallery and Andrews, Tasmanian Museum and Art Gallery, pers. comm.) and the most recent record is from "The Churn", Franklin River, January, 1983 (pers. obs.).

South Australia

The species was never common in South Australia and was restricted to the forests of the coast and the southeastern region of the state. Jones (1923) noted

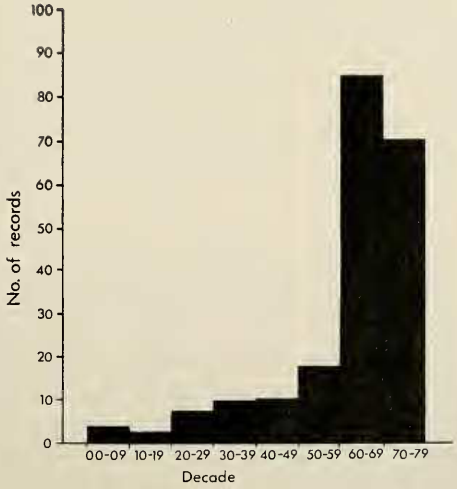

Fig. 3. Records of *D. maculatus* in Victoria by decades since 1900 (221 records).

that there was then still a possibility that the species persisted in the state, however, the most recent specimen is from Barmera, dated August 1958 (S.A. Mus. No. M6187). The species is very rare or extinct in the state. Large areas of the previous range have been converted to pine plantations. The nearest, confirmed present range is in Victoria approximately 100 km from the South Australian border (Fig. 2).

TABLE 1. The number of five-minute blocks in various regions of Victoria that have recent records (post 1959) of *D. maculatus* (unconfirmed Wilsons Promontory records appear in brackets).

Region	Number of post-1959 records in five-minute blocks			
	1	2-3	4-5	6-8
Southwestern	8	3	1	1
Otway Range	10	3	2	1
Mt. Macedon	1	0	0	0
Northeastern	16	2	0	0
Gippsland	28	7	1	4
Wilsons Promontory	1(4)	1	—	—

New South Wales

Records of *D. maculatus* are concentrated on both sides of the Great Dividing Range and one specimen has been recorded as far west as Hay (Fig. 1, Caughley, 1980; Marlow, 1958; Troughton, 1954). Caughley (1980) provides a map of the recent records of the species and regards the species as uncommon in New South Wales although the status varies from region to region and it is more common in the north of the state (Settle, 1978; Calaby, 1966; Scott, 1975). Settle (1978) noted that the destruction of forested areas has greatly reduced the available habitat for this species in the state. The magnitude of the range reduction appears less than in Victoria, however, the population around Hay is probably isolated (Caughley, 1980; Marlow, 1958).

Queensland

The distribution of the species in Queensland is disjunct (Fig. 1) with some authors (e.g. Settle, 1978) according the isolated population between Cooktown and Townsville sub-specific status, *D.m. gracilis* (see Ramsay, 1888). The species is regarded as uncommon in the state, however, any reduction in range since European settlement has not been established (Van Dyck, Queensland Museum, pers. comm.). The most recent museum specimen was collected at Mt. Spurgeon in 1974 although there have been more recent reports from Lamington Plateau; Gatton, Mt. Lindesay Highway and Thornton Peak (Van Dyck, Queensland Museum, pers. comm.).

Victoria

Past distribution. The range of *D. maculatus* in Victoria at the time of European settlement included areas where the mean annual rainfall exceeded 600 mm (Fig. 2). This area, centred on the Great Dividing Range, corresponds to the original distribution of forest types dominated by medium to tall eucalypts, i.e. >10 m (Everett, 1869; Carnahan, 1976). The record from Gunbower in the 1880's (Morrison, 1945) appears anomalous but it is likely that the riparian vegetation along the Murray River provided a corridor of suitable habitat (Kile *et al.*, 1980). Such a conclusion appears to be supported by a record in the Rutherglen area in 1895 (McEvey, 1965) and South Australian records along the Murray River. Thus the perceived range of *D. maculatus* at the time of European settlement, including the corridor to Gunbower, included 60% of Victoria.

Present distribution. Since European settlement, the range of *D. maculatus* in Victoria has contracted and is now disjunct (Fig. 2). Populations in southwestern Victoria, the Otway Range and, probably, Mt. Macedon and Wilsons Promontory are now isolated though the continued presence of *D. maculatus* in the two latter regions is uncertain. The species was observed on Wilsons Promontory in 1902 (Kershaw, 1940) and Fleay (1948) released two pairs in the area in late 1939. Norris *et al.* (1979) commented that subsequent records required confirmation (e.g. McQueen, 1960); these authors were unaware of the recent sightings from Cape Liptrap (Land Conservation Council of Victoria, 1980) and Port Franklin (C. Rossiter (Hedley) pers. comm.). It seems possible that the species may persist in this region. Similarly, its status in the Mt. Macedon area is uncertain because there is only one recent record from this locality. This locality is isolated from the contiguous forest of the Great Dividing Range (Fig. 2).

Since European settlement, the area covered by forest and dense woodland in Victoria has been reduced from about 74% to about 33% (Kile *et al.*, 1980). *D. maculatus* has been recorded in 2.8% (97) of the 3364 5-minute blocks in Victoria. However, in recent times (post-1959) they have been recorded in only 42 of these blocks. These data support the view that the range of *D. maculatus* has been halved in the last 140 years and its range now includes only about 30% of the state (Fig. 2). Within this range there are three areas in which records are concentrated, namely southwestern Victoria, especially the area around the "Stones" (Emison *et al.*, 1978), the Otway Range, especially the area bounded by Lavers Hill, Cape Otway and Deans Marsh (see Emison *et al.*, 1975) and the upper Snowy River valley above Tulloch Arch Gorge (Norris and Mansergh, 1981).

Habitat. Specht *et al.* (1974) identified 24 broad vegetation alliances in Victoria and *D. maculatus* has been recorded in at least four of these, i.e. Tall open-forest, Open-forest, Low open-forest and Woodland. It has also been recorded from areas local residents describe as "rainforest" (= Closed forest). *D. maculatus* is sometimes trapped on farmland, however, such localities are almost invariably near areas of forest. *D. maculatus* has been recorded moving more than 2 km overnight (H.

Bass (Tubbut) pers. comm.) and animals, usually males, taken outside forested areas are presumed to have wandered from their preferred habitat during the breeding season (Mansergh, 1983).

Abundance. It is difficult to establish the past and present abundance of *D. maculatus* for many reasons. One of the main reasons is that the 240 records are not the result of systematic field surveys. Few, if any, of the wide variety of factors influencing the number of records during this century (Fig. 3) have remained constant. In this period land use changes have certainly been extensive. Interest in, and efforts to record the abundance of, wildlife generally have increased suggesting that early estimates of abundance would have been based on poorer records. Furthermore, in discussing the status of dasyurids, Archer (1979) noted the difficulty of determining whether rarity is normal, either as a steady state or at a specific point within a periodic fluctuation or, alternatively, indicative of an abnormal decline (see Hollings, 1973). Despite these limitations, changes in relative abundance may be estimated by consideration of pre-European distribution, factors that may have affected the population since European settlement and estimation of the abundance at present.

Fossil record. Data derived from seventeen Pleistocene and Holocene cave deposits in Victoria were provided by Wakefield (1964, 1967a and b). In these deposits *D. viverrinus* was recorded more frequently than *D. maculatus* (95% and 65% respectively), and in only two deposits were the remains of *D. maculatus* more numerous than *D. viverrinus,* both of these caves being in close proximity to areas where *D. maculatus* is still present, i.e. southwestern Victoria and the Otway Range. Interpretation of these data is difficult as at least some of the deposits were at owl roosts (e.g. Wakefield 1967a) and as a fully grown *D. viverrinus* is about half the weight of *D. maculatus* it would therefore have been preferred prey.

European settlement to 1960

One of the earliest accounts of *D. maculatus* in Victoria is provided by Wheelwright (1861) who believed the species to be rare and only sparingly dispersed through thick bush. Other accounts of the 19th century are in accord with this estimation (Batey, 1907; Wakefield, 1954). In the 1880s John Hallifax (1934) trapped "about 100 native cats for every tiger cat". Certainly, for a time in the late 19th century, 2000-5000 *D. viverrinus* skins were exported annually to England from Australia, but since the skin of *D. maculatus* had no commercial value comparative statistics are not available (Poland, 1892).

Present (post-1960)

Data presented in Figure 3 show a marked increase in the frequency of records since 1960. However, this is almost certainly an artifact of increased trapping and collection rather than an indication of increased numerical abundance as suggested by Hyett and Shaw (1980). For example, active documentation of records of *D. maculatus* by Fisheries and Wildlife Division only began in 1959. Only ten 5-minute

blocks in Victoria (0.3%) have more than four recent records (Table 1) suggesting that *D. maculatus* is not an abundant animal. Furthermore, only four animals have been trapped and one sighted during the surveys conducted by Wildlife Survey Unit since 1973 (see Methods).

In a mammal survey, conducted over 2400 km^2 in the Upper Richmond and Clarence Rivers region (NSW), Calaby (1966) sighted one animal and, with the co-operation of local residents, recorded 13 animals over a three-year period. The highest frequencies recorded from each of the three Victorian areas described above (Distribution section) over any three-year period are: 10 in the Otway Range (1969-71), six in the Upper Snowy River area (1970-72) and six in the south-western area (1966-69).

Factors influencing abundance

In 1935, *Dasyurus* spp. were afforded legal protection (Victorian Government Gazette, 1935) because of a dramatic decline in numbers earlier this century (Lewis, 1934). Nevertheless, documents of the period that relate the decline of *D. maculatus* to an earlier epidemic disease invariably use the generic term native cat.

Previous authors (e.g. Caughley, 1980) have suggested that the introduced disease toxoplasmosis may have caused a decline in *D. maculatus* around the turn of the century. However, there is little direct evidence to support this suggestion (Mundav, 1966; Collins, 1973; Green, 1973; Attwood *et al.*, 1975; Caughley, 1980). Furthermore, as *D. maculatus* has always been rarely observed in Victoria it appears unlikely that a population decline of the magnitude that affected *D. viverrinus* would have been noticed.

There may be other explanations for the decline of *D. maculatus* rather than the introduction of an exotic disease. For example, Batey (1907) observed the demise of *D. viverrinus* and noted that (p.72):

"In 1846 this animal was very numerous, but later at various periods they seemed to be infested with a burrowing maggot which brought them almost to the verge of extinction, and it was sometime before they again regained their numerical strength, but I do not think the attacks of this parasite would alone have sufficed to complete their extinction . . . later on, when the rabbits became plentiful, and had to be trapped many native cats were caught in the traps".

Specimens of *D. maculatus* sent to the Fisheries and Wildlife Division since 1959 (the commencement of *D. maculatus* data sheets) have been frequently infested with the parasitic larvae of the native flea *Uropsylla tasmanica* (Warneke, pers. comm.) and such an affliction is similar to that described by Batey (above) and Fleay (1932). It is not known whether the prevalence of this flea depends on the population density of the host and, consequently, whether such infestations are part of a normal population cycle or are a result of abnormal event(s) acting on a

weakened host population. Consequently the effects of *U. tasmanica* on the past and present population(s) of *D. maculatus* remain unknown.

Both feral cats (*Felis catus*) and foxes (*Vulpes vulpes*) may compete with the Tiger Quoll for food resources (see Brunner *et al.*, 1981), however, the absence of a quantative analysis of the diet of the Tiger Quoll precludes a definitive answer to this question. It is noteworthy that in Tasmania, the state where both the Tiger Quoll and Eastern Quoll are most abundant, there is no feral fox population. In Tasmania the density of the feral cat population appears to be related to the adundance of rabbits (*Oryctolagus cuniculus*) a favoured food item (Green, 1973).

A combination of habitat destruction and the widespread trapping and poisoning in and around forested areas (e.g. Douglas, 1959; Calaby, 1966; Rolls, 1969; McIlroy, 1981; Settle, 1978) were probably responsible for the extinction of *D. maculatus* in many areas. Anecdotal evidence gives varying times for local disappearances and reappearances of *D. maculatus* (e.g. McEvey, 1965; Baade, 1925).

Status and conservation

At the time of European settlement the range of *D. maculatus* included five states. It is now considered very rare or extinct in South Australia, rare in Victoria, uncommon in Queensland and common to uncommon in New South Wales and Tasmania. Some of the problems associated with the conservation of the species in Victoria are discussed below, however, it is considered by the author that similar problems occur in other parts of its range.

The range reduction in Victoria has probably been caused by a number of factors, the major one being habitat destruction. The precise habitat requirements of *D. maculatus* are not known, although it is dependent upon the remaining forested areas (Fig. 2). It is important that areas where *D. maculatus* is frequently recorded, i.e. around the "Stones", Otway Range and East Gippsland, receive adequate protection. Existing National Parks and Wildlife Reserves are probably inadequate (e.g. Norris and Mansergh, 1981). It is also notable that in February 1983 severe and extensive bushfires occurred in the Otway Range, Mt. Macedon and East Gippsland areas. The latter fire covered a forested area of over 2000 km^2.

In Victoria, the conservation status of the four vegetation alliances (see Habitat section) in which *D. maculatus* has been recorded, vary from "nil to reasonable" (Specht *et al.*, 1974). Forests and dense woodland now cover about 33% of Victoria (Kile *et al.*, 1980), however, only 2% of forests in Victoria are in National Parks whilst 41% are designated as State Forest, 47% are gazetted in other public land categories over which the Forests Commission of Victoria retains timber rights and 10% of forests are privately owned (Australia, Senate, 1981).

Furthermore, as no comprehensive system of corridors between reserves has been incorporated into the reserve system there is a possibility that the Victorian

populations of *D. maculatus* will be further fragmented. It is therefore important that land uses outside the reserve system do not destroy extensive areas of *D. maculatus* habitat.

Major land use changes, involving clearfelling of the native forest, have been proposed for several regions where *D. maculatus* is most frequently recorded, i.e. East Gippsland (Scott, 1981) and Otway Range (Forests Commission of Victoria, 1981). The effects of these practices on *D. maculatus* have not been studied, although adverse effects on potential food sources and reduced availability of breeding hollows occur (Recher *et al.,* 1980). The species occurred in the Boola Boola State Forest last century and was recorded near the edge of this forest in 1966. However, in a study of the effects of clearfelling on wildlife in Boola Boola State Forest, Loyn *et al.* (1980) found no evidence that the species still occurred in the area. Elsewhere clearfelling and related land use practices in forested areas have caused concern for the survival of *D. maculatus,* for example in Tasmania (Pattemore, 1977). Recher *et al.* (1980) obtained only one locality record in a five-year study of the Eden woodchipping region, where it was previously described as possibly endangered (Scott, 1975).

As the majority of the species' range currently occurs outside reserves it is important that land management be orientated towards ensuring the persistance of the species in these areas. However, management strategies can only be evaluated after a basic knowledge of the ecology of the species is obtained.

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